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PLANKTONIC COPEPODS FROM AYSÉN FJORD AND ADJACENT WATERS, SOUTHERN CHILE

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Abstract: Species composition of the planktonic copepods was examined on the materials taken during the period from 1980 to 1986 in Aysén Fjord and Moraleda Channel, southern Chile. Of a total of 38 species encountered, four cold water oceanic species and four warm water oceanic species were used to detect the influence of the Subantarctic Surface Water and Equatorial Subsurface Water masses on this area, respectively. In particular, the relationships between the occurrence of the warm water oceanic species associations and the offshore current systems are discussed.

1. Introduction

Several papers on zooplankton ecology in Chilean fjord waters have been published (*cf.*, ARCOS, 1974, 1976; ANTEZANA *et al.*, 1976; ANTEZANA, 1976, 1981) since a series of expeditions ("HERO 72–4, 73–2" cruises, etc.) to the Magallanes regions were carried out. Moreover, sepcies composition and distribution of zooplankton, especially copepods were recently reported (HIRAKAWA and ZAMA, 1985; MARIN and ANTEZANA, 1985). However, as these investigations have been restricted to certain seasons, seasonal change of zooplankton and species composition throghout the year have not been clarified yet.

In relation to the introduction of the Pacific salmon, primarily *Oncorhynchus keta* from Japan to the Chilean fjord, distribution of zooplankton which are important food items for the released juvenile salmon was investigated by Japan Internatioal Cooperation Agency (JICA) and Servicio Nacional de Pesca (SERNAP) of the Republic of Chile during the period from 1980 to 1986. The purpose of this paper is to describe the species composition of the planktonic copepods which are the most abundant group of zooplankton in Aysén Fjord (45°20′S, 73°05′W) and Moraleda Channel (45°25′S, 73°40′W) (Fig. 1, A). This area is of particular interest from the relationships between the zooplankton community and the current systems (Fig. 1) off the west coast of southern Chile (SILVA and NESHYBA, 1977). For example, ANTEZANA *et al.* (1976) suggested that the Chilean fjords may be areas of intrusion of antarctic allochthonous zooplankton species, from a substantial capture of juveniles of antarctic krill, *Euphausia superba* in the area of 'Isla Guarello' (50°17.4′S, 75°19.5′W).

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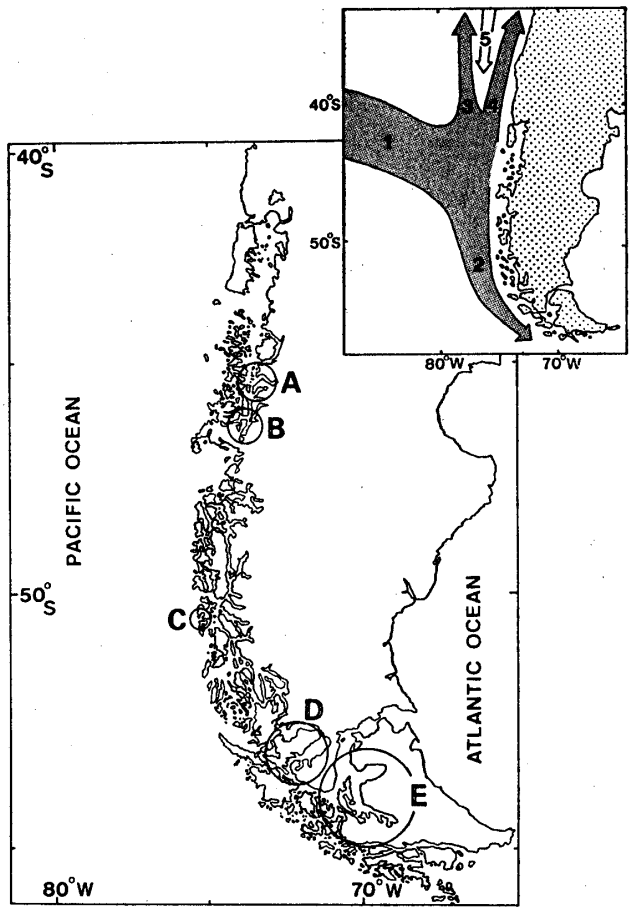

Fig. 1. Location of zooplankton sampling areas (A: present study, B: HIRAKAWA and ZAMA, 1985, C: MARIN and ANTEZANA, 1985, D: ARCOS, 1976, E: BRADY, 1883; ARCOS, 1976) in the Chilean fjords. Schematic diagram of the surface currents shown by SILVA and NESHYBA (1977) is on the right-upper side. 1. West Wind Drift. 2, Cape Horn Current, 3. Humbolt Oceanic Current, 4. Humbolt Coastal Current, 5. Peru-Chile Countercurrent. 1–4; Cold currents, 5; Warm current.

2. Materials and Methods

Over 300 samples were extensively collected by vertical tows with a Norpac net (0.33 mm mesh openings) and by simultaneous horizontal tows with multiple MTD nets (0.33 mm mesh openings) in the waters of Aysén Fjord (A area) during the period from June 1980 to December 1986 in the routine plankton sampling programs as part of the JICA project. For example, duplicate vertical tows were made at approximately monthly intervals from near the bottom (7 m depth) to the surface in Ensenada Baja, a lagoon at the head of Aysén Fjord. Consequently, a total of samples at A area reached its maximum in those from the five areas (A–E) in Fig. 1. These samples were firstly examined to clarify seasonal change and diurnal vertical distribution of the major zooplankters. Details of data on zooplankton sampling and a part of the results have been preliminarily shown in the JICA technical reports (HIRAKAWA, 1984, 1985; HIRAKAWA *et al.*, 1985).

3. Results

A total of 38 copepod species listed in Table 1 were identified. Fourteen species were recorded for the first time from the Chilean fjords.

Of seven cold water species, *Clausocalanus brevipes*, *Drepanopus forcipatus*, *Metridia*

*Table 1. List of planktonic copepod species found from the samples collected with a Norpac net and MTD nets in the waters of Aysén Fjord during the period from June 1980 to December 1986. △: cold water species, ▲: warm water species, *: new record of the species for the Chilean fjords.*

Calanoida
- *Calanus chilensis* BRODSKY
- △ *Calanus simillimus* GIESBRECHT
- ▲ *Calanus minor* (CLAUS)
- △ *Neocalanus tonsus* (BRADY)
- *Calanoides patagoniensis* BRADY
- * *Mesocalanus tenuicornis* s. 1. (DANA)
- *Rhincalanus nasutus* GIESBRECHT
- *Paracalanus parvus* (CLAUS)
- ▲ * *Calocalanus styliremis* GIESBRECHT
- * *Microcalanus pusillus* SARS
- ▲ *Clausocalanus arcuicornis* (DANA)
- △ *Clausocalanus brevipes* FROST and FLEMINGER
- △ *Drepanopus forcipatus* GIESBRECHT
- *Aetideus armarus* (BOECK)
- *Chiridius poppei* GIESBRECHT
- △ *Pareuchaeta antarctica* (GIESBRECHT)
- *Scolecithricella minor* (BRADY)
- * *Parundinella* sp.
- △ *Metridia lucens* BOECK
- *Centropages abdominalis* SATO
- *Centropages brachiatus* (DANA)
- * *Boeckella titicacae* HARDING
- * *Boeckella* sp.
- * *Lucicutia* sp.
- △ *Candacia cheirura* CLEVE
- *Acartia omorii* BRADFORD
- *Acartia tonsa* DANA
- * *Acartia* sp.

Cyclopoida
- *Oithona atlantica* FARRAN
- ▲ *Oithona davisae* FERRARI and ORSI
- *Oithona similis* CLAUS
- * *Oncaea media* GIESBRECHT
- * *Oncaea subtilis* GIESBRECHT
- * *Oncaea venusta* PHILIPPI
- ? *Corycaeus affinis* MCMURRICH
- ▲ * *Corycaeus dubius* FARRAN
- * *Macrocheiron* sp.

Harpacticoida
- * *Microsetella norvegica* (BOECK)

lucens and *Candacia cheirura* were found in Aysén Fjord and Moraleda Channel through all seasons. *D. forcipatus* and *M. lucens* were numerically major zooplankters in this study area, of which the former was the most dominant species (av. 248 individ./m^3) in summer of the channel when zooplankton abundance reached its seasonal maximum. *C. brevipes* occurred more abundantly in summer as well as *D. forcipatus*, while *M. lucens* dominated in spring and autumn. The abundance of these three species was low in winter as a whole. *C. cheirura* was also consistently found but in small numbers (less than 6 individ./m^3) as in *Calanus simillimus*, *Neocalanus tonsus* and *Pareuchaeta antarctica* taken mainly at night (2300–2330) only by MTD net tows in September and October 1983. Moreover, four warm water species except for *Oithona davisae*, the occurrence of which can be attributed to a synanthropic introduction by ship ballast water (HIRAKAWA, 1988), *Calanus minor*, *Calocalanus styliremis*, *Clausocalanus arcuicornis* and *Corycaeus dubius* were scarce (less than 4 individ./m^3) in abundance, occurring only rarely (once or twice) from summer to autumn. *C. minor*, *C. arcuicornis* and *P. antarctica* occurred in the fjord and channel, while *C. simillimus*, *N. tonsus*, *C. styliremis* and *C. dubius* were found in the channel.

Of the above-mentioned 11 copepod species, it is expected that *C. brevipes*, *D. forcipatus* and *M. lucens* would breed successfully and maintain healthy populations in the Aysén waters, because their early copepodid stages were taken more abundantly along with the adults (including females and males) from spring to autumn. However, the other species are considered to have been recruited by advective introduction from other areas, lacking signs of reproductive success in this area from their temporary occurrences and/or low densities.

4. Discussion

C. similimus, *N. tonsus*, *C. brevipes* and *C. cheirura* have been classified as subantarctic oceanic species and *P. antarctica* as a typical antarctic oceanic species by several workers. *C. brevipes* is regarded as a more tolerant oceanic species which can actively reproduce in the coastal waters despite greatly changed hydrographic conditions. On the other hand, *C. minor*, *C. styliremis*, *C. arcuicornis* and *C. dubius* have the original centers of their reproduction from tropical and/or subtropical to temperate waters, and are generally described as oceanic species. Therefore, these eight species except for *C. brevipes* can be used to indicate more adequately the distribution of particular types of water masses in this study area. Though the Subantarctic Surface Water and Equatorial Subsurface Water (the Peru-Chile Countercurrent) masses identified from T-S diagram off the Archipelago were not observed in this fjord area (VARGAS, 1983), the occurrence of the cold and warm water oceanic species clearly indicates that the waters of the Aysén fjord are subject to the influence of the two intruding offshore waters.

In addition, the other indicator species of copepods have been recorded from the more southern fjord waters previously investigated (Table 2). STONE (1980) described a particular intrusion of a higher salinity and density water from offshore into Knight Inlet situated to the northwest of Vancouver (British Columbia, Canada), which carried a high proportion of unusual zooplankton, almost all of southern origin. Evidence for the presence of equatorial water on the continental shelf north of Vancouver Island was supported by the occurrence of six subtropical zooplankton species (GARDNER, 1982). Accordingly, the Chilean fjords may be areas not only of intrusion of antarctic-subantarctic zooplankters but also those of subtropical zooplankters associated with the transport of the Peru-Chile Countercurrent, similar to the intrusion system demonstrated in the coastal waters of British Columbia.

Table 2. Indicator species of copepods from the southern Chilean fjords and adjacent waters previously investigated.

Indicator species*	Area	Reference
Cold water species		
Eucalanus longiceps MATTHEWS	C	MARIN and ANTEZANA (1985)
Euchaeta bilosa (FARRAN)	D, E	ARCOS (1976)
Clausocalanus laticeps FARRAN	C	MARIN and ANTEZANA (1985)
Warm water species		
Eucalanus subtenuis GIESBRECHT	C	MARIN and ANTEZANA (1985)
Clausocalanus mastigophorus (CLAUS)	Baja di Churruca	GIESBRECHT (1888)
Euchirella rostrata (CLAUS)	C	MARIN and ANTEZANA (1985)
Scolecithricella bradyi (GIESBRECHT)	D	ARCOS (1976)
Centropages bradyi WHEELER	C	MARIN and ANTEZANA (1985)
Pleuromamma abdominalis (LUBBOCK)	E	BRADY (1883)
Heterorhabdus spinifrons (CLAUS)	Seno Baker and Fiordo Iceberg	ARCOS (1974)

* except for those in Table 1.

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